

are required in producing the most beautiful shades of color when blended one with another, the color being brought out by calcination.

Mixing Oil Colors and Tints.—It must not be expected that the formulas given will produce the exact effect desired, because the strength of the various brands of colors vary to a great extent, and therefore the painter must exercise his own judgment. The table simply gives an idea of what can be produced by following the formulas given, when chemically pure material is employed in the mixing. It is also recommended that the parts mentioned be weighed out in paste form, and the white or black and each color separately thinned and strained before mixing them together, because the arriving at the proper hue of color or depth and tone of tint will be simplified by using that precaution. By thinning it is not meant that they should be quite ready for application, but of such consistency that they will pass an ordinary strainer with the aid of a brush.

Unless otherwise indicated, the materials are understood to be ground fine in paste form.

NOTE.—The majority of the following are by Joseph Griggs, in the *Painters' Magazine*:

GROUNDS FOR GRAINING COLORS:

Ash Ground.—Four hundred parts white lead; 4 parts French ocher; 1 part raw Turkey umber.

Ash.—Raw umber; raw sienna; and a little black or Vandyke brown.

Hungarian Ash.—Raw sienna and raw and burnt umber.

Bun Ash.—Raw sienna; burnt umber; and Vandyke brown.

Cherry Ground.—One hundred parts white lead; 5 parts burnt sienna; 1 part raw sienna.

Natural Cherry.—Raw and burnt sienna and raw umber.

Stained Cherry.—Burnt sienna; burnt umber; and Vandyke brown.

Chestnut.—Raw sienna; burnt umber; Vandyke brown; and a little burnt sienna.

Maple.—Raw sienna and raw umber.

Silver Maple.—Ivory black over a nearly white ground.

Light Maple Ground.—One hundred parts white lead; 1 part French ocher.

Dark Maple Ground.—One hundred

parts white lead; 1 part dark golden ocher.

Oak.—Raw sienna; burnt umber; a little black.

Pollard Oak.—Raw and burnt sienna, or burnt umber and Vandyke brown.

Light Oak Ground.—Fifty parts white lead; 1 part French ocher.

Dark Oak Ground.—Fifty parts white lead; 1 part dark golden ocher.

Satinwood.—Add a little ivory black to maple color.

Mahogany.—Burnt sienna; burnt umber; and Vandyke brown.

Mahogany Ground.—Ten parts white lead; 5 parts orange chrome; and 1 part burnt sienna.

Rosewood.—Vandyke brown and a little ivory black.

Rosewood Ground.—Drop black.

Walnut Ground.—Fifty parts white lead; 3 parts dark golden ocher; 1 part dark Venetian red; and 1 part drop black.

Black Walnut.—Burnt umber with a little Vandyke brown for dark parts.

French Burl Walnut.—Same as black walnut.

Hard Pine.—Raw and burnt sienna; add a little burnt umber.

Cypress.—Raw and burnt sienna and burnt umber.

Whitewood.—Ground same as for light ash; graining color, yellow ocher, adding raw umber and black for dark streaks.

POSITIVE COLORS:

Blue.—Twelve parts borate of lime; 6 parts oxide of zinc; 10 parts litharge; 9 parts feldspar; 4 parts oxide of cobalt.

Blue Black A.—Nine parts lampblack; 1 part Chinese or Prussian blue.

Blue Black B.—Nineteen parts drop black; 1 part Prussian blue.

Bright Mineral.—Nine parts light Venetian red; 1 part red lead.

Brilliant Green.—Nine parts Paris green; 1 part C. C. chrome green, light.

Bronze Green, Light.—Three parts raw Turkey umber; 1 part medium chrome yellow.

Bronze Green, Medium.—Five parts medium chrome yellow; 3 parts burnt Turkey umber; 1 part lampblack.

Bronze Green, Dark.—Twenty parts drop black; 2 parts medium chrome yellow; and 1 part dark orange chrome.

Bottle Green.—Five parts commercial chrome green, medium, and 1 part drop black.

Brown.—Ten parts crude antimony; 12 parts litharge; 2 parts manganese; 1 part oxide of iron.

Brown Stone.—Eighteen parts burnt umber; 2 parts dark golden ocher; and 1 part burnt sienna.

Cherry Red.—Equal parts of best imitation vermilion and No. 40 carmine.

Citron A.—Three parts medium chrome yellow and 2 parts raw umber.

Citron B.—Six parts commercial chrome green, light, and 1 part medium chrome yellow.

Coffee Brown.—Six parts burnt Turkey umber; 2 parts French ocher; and 1 part burnt sienna.

Emerald Green.—Use Paris green.

Green.—Twenty parts litharge; 12 parts flint; 2 parts oxide of copper; $2\frac{1}{2}$ parts ground glass; $2\frac{1}{2}$ parts whiting; $1\frac{1}{2}$ parts oxide of chrome.

Flesh Color.—Nineteen parts French ocher; 1 part deep English vermilion.

Fern Green.—Five parts lemon chrome yellow and 1 part each of light chrome green and drop black.

Foliage Green.—Three parts medium chrome yellow and 1 part of ivory or drop black.

Foliage Brown.—Equal parts of Vandyke brown and orange chrome yellow.

Golden Ocher.—Fourteen parts French yellow ocher and 1 part medium chrome yellow for the light shade, and 9 parts Oxford ocher and 1 part orange chrome yellow for the dark shade.

Gold Russet.—Five parts lemon chrome yellow and 1 part light Venetian red.

Gold Orange.—Equal parts of dry orange mineral and light golden ocher in oil.

Indian Brown.—Equal parts of light Indian red, French ocher, and lamp black.

Mahogany, Cheap.—Three parts dark golden ocher and 1 part of dark Venetian red.

Maroon, Light.—Five parts dark Venetian red; 1 part drop black.

Maroon, Dark.—Nine parts dark Indian red; 1 part lampblack.

Olive Green.—Seven parts light golden ocher; 1 part drop black.

Ochrous Olive.—Nine parts French ocher; 1 part raw umber.

Orange Brown.—Equal parts burnt sienna and orange chrome yellow.

Oriental Red.—Two parts Indian red, light, in oil; 1 part dry red lead.

Purple A.—Eight parts crocus martis; 2 parts red hematite; 1 part oxide of iron.

Purple B.—Two parts rose pink; 1 part ultramarine blue.

Purple Black.—Three parts lampblack and 1 part rose pink, or 9 parts drop black and 1 part rose pink.

Purple Brown.—Five parts Indian red, dark, and 1 part each of ultramarine blue and lampblack.

Roman Ocher.—Twenty-three parts French ocher and 1 part each burnt sienna and burnt umber.

Royal Blue, Dark.—Eighteen parts ultramarine blue and 2 parts Prussian blue. To lighten use as much white lead or zinc white as is required.

Royal Purple.—Two parts ultramarine blue; 1 part No. 40 carmine or carmine lake.

Russet.—Fourteen parts orange chrome yellow and 1 part C. P. chrome green, medium.

Seal Brown.—Ten parts burnt umber; 2 parts golden ocher, light; 1 part burnt sienna.

Snuff Brown.—Equal parts burnt umber and golden ocher, light.

Terra Cotta.—Two parts white lead; 1 part burnt sienna; also 2 parts French ocher to 1 part Venetian red.

Turkey Red.—Strong Venetian red or red oxide.

Tuscan Red, Ordinary.—Nine parts Indian red to 1 part rose pink.

Brilliant.—Four parts Indian red to 1 part red madder lake.

Violet.—Three parts ultramarine blue; 2 parts rose lake; 1 part best ivory black.

Yellow.—Four and one-half parts tin ashes; 1 part crude antimony; 1 part litharge; and 1 part red ocher.

Yellow, Amber.—Ten parts medium chrome yellow; 7 parts burnt umber; 3 parts burnt sienna.

Yellow, Canary.—Five parts white lead; 2 parts permanent yellow; 1 part lemon chrome yellow.

Yellow, Golden.—Ten parts lemon chrome yellow; 3 parts orange chrome, dark; 5 parts white lead.

Yellow, Brimstone.—Three parts white lead; 1 part lemon chrome yellow; 1 part permanent yellow.

Azure Blue.—Fifty parts white lead; 1 part ultramarine blue.

Blue Gray.—One hundred parts white lead; 3 parts Prussian blue; 1 part lamp-black.

Bright Blue.—Twenty parts zinc white; 1 part imitation cobalt blue.

Blue Grass.—Seven parts white lead; 2 parts Paris green; 1 part Prussian blue.

Deep Blue.—Fifteen parts white lead; 1 part Prussian blue or Antwerp blue.

French Blue.—Five parts imitation cobalt blue; 2 parts French zinc white.

Green Blue.—One hundred parts white lead; 5 parts lemon chrome yellow; 3 parts ultramarine blue.

Hazy Blue.—Sixty parts white lead; 16 parts ultramarine blue; 1 part burnt sienna.

Mineral Blue.—Five parts white lead; 4 parts imitation cobalt blue; 2 parts red madder lake; 1 part best ivory or drop black.

Orient Blue.—Twenty-five parts white lead; 2 parts Prussian blue; 1 part lemon chrome yellow.

Royal Blue.—Thirty-four parts white lead; 19 parts ultramarine blue; 2 parts Prussian blue; 1 part rose madder or rose lake.

Sapphire Blue.—Two parts French zinc white and 1 part best Chinese blue.

Sky Blue.—One hundred parts white lead; 1 part Prussian blue.

Solid Blue.—Five parts white lead; 1 part ultramarine blue.

Turquoise Blue.—Twenty parts white lead; 3 parts ultramarine blue; 1 part lemon chrome yellow.

RED TINTS:

Cardinal Red.—Equal parts of white lead and scarlet lake.

Carnation Red.—Fifteen parts white lead; 1 part scarlet lake.

Claret.—Twenty-one parts oxide of zinc; 4 parts crocus martis; 4 parts oxide of chrome; 3 parts red lead; 3 parts boracic acid.

Coral Pink.—Fifteen parts white lead; 2 parts bright vermilion; 1 part deep orange chrome.

Deep Rose.—Ten parts white lead; 1 part red lake.

Deep Purple.—Five parts white lead; 1 part ultramarine blue; 1 part rose pink.

Deep Scarlet.—Fifteen parts bright vermilion; 2 parts red lake; 5 parts white lead.

Flesh Pink.—One hundred parts white lead; 1 part orange chrome yellow; 1 part red lake.

Indian Pink.—One hundred parts white lead; 1 part light Indian red.

Lavender.—Fifty parts white lead; 2 parts ultramarine blue; 1 part red lake.

Light Pink.—Fifty parts white lead; 1 part bright vermilion.

Lilac.—Fifty parts white lead; 1 part best rose pink.

Mauve.—Fifteen parts white lead; 2 parts ultramarine blue; 1 part carmine lake or red lake.

Orange Pink.—Two parts white lead; 1 part dark orange chrome or American vermilion.

Purple.—Five parts white lead; 2 parts ultramarine blue; 1 part red madder lake.

Royal Pink.—Five parts white lead; 1 part carmine lake or red madder lake.

Royal Rose.—Twenty parts white lead; 1 part rich rose lake.

Red Brick.—Ten parts white lead; 3 parts light Venetian red; 1 part yellow ochre.

Reddish Terra Cotta.—Two parts white lead; 1 part rich burnt sienna.

Salmon.—Fifty parts white lead; 5 parts deep orange chrome.

Shell Pink.—Fifty parts white lead; 2 parts bright vermilion; 1 part orange chrome; 1 part burnt sienna.

Violet.—Fifteen parts white lead; 4 parts ultramarine blue; 3 parts rose lake; 1 part drop black.

GREEN TINTS:

Apple Green.—Fifty parts white lead; 1 part chrome green, light or medium shade.

Citrine Green.—One hundred parts white lead; 2 parts medium chrome yellow; 1 part drop black.

Citron Green.—One hundred parts white lead; 3 parts medium chrome yellow; 1 part lampblack.

Emerald Green.—Ten parts white lead; 1 part Paris (emerald) green.

Grass Green A.—Five parts white lead; 7 parts Paris green.

Grass Green B.—Ten parts oxide of chrome; 2 parts tin ashes; 5 parts whitening; 1 part crocus martis; 1 part bichromate potash.

Gray Green.—Five parts white lead; 1 part Verona green.

Marine Green.—Ten parts white lead; 1 part ultramarine green.

Nile Green.—Fifty parts white lead; 6 parts medium chrome green; 1 part Prussian blue.

Olive Green.—Fifty parts white lead; 2 parts medium chrome yellow; 3 parts raw umber; 1 part drop black.

Olive Drab.—Fifty parts white lead; 8 parts raw umber; 5 parts medium chrome green; 1 part drop black.

Pea Green.—Fifty parts white lead; 1 part light chrome green.

Satin Green.—Three parts white lead; 1 part Milori green.

Sage Green.—One hundred parts white lead; 3 parts medium chrome green; 1 part raw umber.

Sea Green.—Fifty parts white lead; 1 part dark chrome green.

Stone Green.—Twenty-five parts white lead; 2 parts dark chrome green; 3 parts raw umber.

Velvet Green.—Twenty parts white lead; 7 parts medium chrome green; 2 parts burnt sienna.

Water Green.—Fifteen parts white lead; 10 parts French ocher; 1 part dark chrome green.

BROWN TINTS:

Chocolate.—Twenty-five parts white lead; 3 parts burnt umber.

Cocanut.—Equal parts white lead and burnt umber.

Cinnamon.—Ten parts white lead; 2 parts burnt sienna; 1 part French ocher.

Dark Drab.—Forty parts white lead; 1 part burnt umber.

Dark Stone.—Twenty parts white lead; 1 part raw umber.

Fawn.—Fifty parts white lead; 3 parts burnt umber; 2 parts French ocher.

Golden Brown.—Twenty-five parts white lead; 4 parts French ocher; 1 part burnt sienna.

Hazel Nut Brown.—Twenty parts white lead; 5 parts burnt umber; 1 part medium chrome yellow.

Mulberry.—Ten parts manganese; 2 parts cobalt blue; 2 parts saltpeter.

Purple Brown.—Fifty parts white lead; 6 parts Indian red; 2 parts ultramarine blue; 1 part lampblack.

Red Brown.—Twelve parts hematite ore; 3 parts manganese; 7 parts litharge; 2 parts yellow ocher.

Seal Brown.—Thirty parts white lead; 5 parts burnt umber; 1 part medium chrome yellow.

Snuff Brown.—Twenty-five parts white lead; 1 part burnt umber; 1 part Oxford ocher.

GRAY TINTS:

Ash Gray.—Thirty parts white lead; 2 parts ultramarine blue; 1 part burnt sienna.

Cold Gray.—Five hundred parts white lead; 6 parts lampblack; 1 part Antwerp blue.

Dove Color.—Twelve parts manganese; 5 parts steel filings; 3 parts whiting; 1 part oxide of cobalt.

Dove Gray.—Two hundred parts white lead; 5 parts ultramarine blue; 2 parts drop black.

French Gray.—One hundred and fifty parts white lead; 2 parts lampblack; 1 part orange chrome yellow; 1 part chrome red (American vermilion).

Lead Color.—Fifty parts white lead; 1 part lampblack (increase proportion of white lead for light tints).

Lustrous Gray.—Ten parts white lead; 1 part graphite (plumbago).

Olive Gray.—Two hundred parts white lead; 2 parts lampblack; 1 part medium chrome green.

Pure Gray.—One hundred parts white lead; 1 part drop black.

Pearl Gray.—One hundred parts white lead; 1 part ultramarine blue; 1 part drop black.

Silver Gray.—One hundred and fifty parts white lead; 2 parts lampblack; 3 parts Oxford ocher.

Warm Gray.—One hundred parts white lead; 3 parts drop black; 2 parts French ocher; 1 part light Venetian red.

NOTE.—For inside work and whenever desirable, the white lead may be replaced by zinc white or a mixture of the two white pigments may be used. Be it also remembered that pure colors, as a rule, will produce the cleanest tints and that fineness of grinding is an important factor. It will not be amiss to call attention to the fact that the excessive use of driers, especially of dark japans or liquid driers, with delicate tints is bad practice, and liable to ruin otherwise good effects in tints or delicate solid colors.

COLOR TESTING.

Expense and trouble deter many a painter from having a color examined,

although such an examination is often very necessary. For the practical man it is less important to know what percentage of foreign matter a paint contains, but whether substances are contained therein, which may act injuriously in some way or other.

If a pigment is to be tested for arsenic, pour purified hydrochloric acid into a test tube or a U-shaped glass vessel which withstands heat, add a little of the pigment or the colored fabric, wall paper, etc. (of pigment take only enough to strongly color the hydrochloric acid simply in the first moment), and finally a small quantity of stannous chloride. Now heat the test tube with its contents moderately over a common spirit lamp. If the liquid or mass has assumed a brown or brownish color after being heated, arsenic is present in the pigment or fabric, etc.

An effective but simple test for the durability of a color is to paint strips of thick paper and nail them on the wall in the strongest light possible. A strip of paper should then be nailed over one-half of the samples of color so as to protect them from the light. On removing this the difference in shade between the exposed and unexposed portions will be very apparent. Some colors, such as the vermilionettes, will show a marked difference after even a few weeks.

Testing Body Colors for Gritty Admixtures.—The fineness of the powdered pigment is not a guarantee of the absence of gritty admixtures. The latter differ from the pigment proper in their specific gravity. If consisting of metallic oxides or metallic sulphides the sandy admixtures are lighter than the pigments and rise to the surface upon a systematic shaking of the sample. In the case of other pigments, e. g., aluminas and iron varnish colors, they collect at the bottom. For carrying out the test, a smoothly bored metallic tube about $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter and 6 to 7 inches long is used. Both ends are closed with screw caps and at one side of the tube some holes about $\frac{1}{8}$ of an inch in diameter are bored, closed by pieces of a rubber hose pushed on. The tube is filled with the pigment powder, screwed up and feebly shaken for some time in a vertical position (the length of time varying according to the fineness of the powder). Samples may now be taken from all parts of the tube. Perhaps glass tubes would be preferable, but lateral apertures cannot be so readily made. After the necessary samples have been

collected in this manner, they must be prepared with a standard sample, which is accomplished either by feeling the powder between the fingers or by inspecting it under a microscope, or else by means of the scratching test, which last named is the usual way. The requisites for these scratch tests consist of two soft, well-polished glass plates ($2\frac{1}{2} \times 2\frac{1}{4}$ inches) which are fixed by means of cement in two stronger plates of hard wood suitably hollowed out. The surface of the glass must project about $\frac{1}{2}$ inch over the wooden frame. If a sample of the pigment powder is placed on such a glass plate, another plate is laid on top and both are rubbed slowly together; this motion will retain a soft, velvety character in case the pigment is free from gritty admixtures; if otherwise, the glass is injured and a corresponding sound becomes audible. Next the powder is removed from the plate, rubbing the latter with a soft rag, and examining the surface with a microscope. From the nature of the scratches on the plate the kind of gritty ingredients can be readily determined. The human finger is sufficiently sensitive to detect the presence of gritty substances, yet it is not capable of distinguishing whether they consist of imperfectly reduced or badly sifted grains of pigment or real gritty admixtures.

To Determine the Covering Power of Pigments.—To determine the covering power of white lead, or any other pigment, take equal quantities of several varieties of white lead and mix them with a darker pigment, black, blue, etc., the latter also in equal proportions. The white lead which retains the lightest color is naturally the most opaque. In a similar manner, on the other hand, the mixing power of the dark pigments can be ascertained. If experiments are made with a variety of white lead or zinc white, by the admixture of dark pigments, the color which tints the white lead or zinc white most, also possesses the greatest covering or mixing power.

To Detect the Presence of Aniline in a Pigment.—Lay a little of the color upon letter paper and pour a drop of spirit on it. If it is mixed with aniline the paper is colored right through thereby, while a pure pigment does not alter the shade of the paper and will never penetrate it.

Vehicle for Oil Colors.—Petroleum, 20 to 30 pounds; tallow, 3 to 5 pounds; cotton-seed oil, 5 to 7 pounds; colophony, 5 to 7 pounds. The pigments

having been ground up with this mixture, the mixed paint can be made still better by adding to it about a sixth of its weight of the following mixture: Vegetable oil, 8 to 20 pounds; saponified rosin, 6 to 16 pounds; turpentine, 4 to 30 ounces.

Frankfort Black.—Frankfort black, also known as German black, is a name applied to a superior grade of lamp-black. In some districts of Germany it is said to be made by calcining wine lees and tartar. The material is heated in large cylindrical vessels having a vent in the cover for the escape of smoke and vapors that are evolved during the process. When no more smoke is observed, the operation is finished. The residuum in the vessels is then washed several times in boiling water to extract the salts contained therein and finally is reduced to the proper degree of fineness by grinding on a porphyry.

Paris Green.—Emerald or Paris green is rather permanent to light, but must not be mixed with pigments containing sulphur, because of the tendency to blacken when so mixed. It will not resist acids, ammonia, and caustics.

PIGMENT PAPER:

See Photography.

PILE OINTMENTS.

I.—“Extract” witch-	
hazel.....	2 fluidounces
Lanum.....	2 ounces
Petrolatum.....	6 ounces
Glycerine.....	4 fluidounces
Tannic acid.....	1 drachm
Powdered opium.....	1 drachm

II.—Tannic acid.....		20 grains
Bismuth subni-		
trate.....	1 drachm	
Powdered opium.....	10 grains	
Lanum.....	3 drachms	
Petrolatum.....	5 drachms	

PINE SYRUP:

See Essences and Extracts.

PINEAPPLE ESSENCE:

See Essences and Extracts.

PINEAPPLE LEMONADE:

See Beverages.

PING PONG FRAPPÉ:

See Beverages, under Lemonades.

PINS OF WATCHES:

See Watchmakers' Formulas.

PINION ALLOY:

See Watchmakers' Formulas.

PINK SALVE:

See Ointments.

PINKEYE:

See Veterinary Formulas.

PIPE-JOINT CEMENT:

See Cement.

PIPE LEAKS:

See Leaks.

PLANT PARASITES:

A spray which will destroy most plant parasites can be made as follows: Dissolve 5 pounds of copper sulphate, 5 pounds quicklime in 50 gallons of water. You can use this spray on pear, apple and cherry trees with good results.

PLANTS:

Temperature of Water for Watering Plants.—Experiments were made several years ago at the Wisconsin Agricultural Experiment Station to determine whether cold water was detrimental to plants. Plants were grown under glass and in the open field, and in all cases the results were similar. Thus, coleus planted in lots of equal size and vigor were watered with water at 35°, 50°, 65°, and 86° F. At the end of 60 days it was impossible to note any difference, and when the experiment was repeated with water at 32°, 40°, 70°, and 100° F., the result was the same. Beans watered with water at 32°, 40°, 70°, and 100° F., were equally vigorous; in fact, water at 32° and 40° F. gave the best results. Lettuce watered with water at 32° F. yielded slightly more than the other lots. From these experiments it was concluded that for vegetable and flowering plants commonly grown under glass, ordinary well or spring water may be used freely at any time of the year without warming.

PLANT PRESERVATIVES:

See Flowers.

Plaster

(See also Gypsum.)

Therapeutic Grouping of Medicinal Plasters.—The vehicle for medicated plasters requires some other attribute than simply adhesiveness. From a study of the therapy of plasters they may be put in three groups, similarly to the ointments with reference to their general therapeutic uses, which also governs the selection of the respective vehicles.

1.—**Epidermatic:** Supportive, protective, antiseptic, counter-irritant, vesicant. Vehicle: Rubber or any suitable

adhesive. Official plasters: Emp. ad-hesivum, E. capsici.

2.—Endermatic: Anodyne, astringent, alterative, resolvent, sedative, stimulant. Vehicle: Oleates or lead plaster, sometimes with rosins or gum rosins. Official plasters: Emp. Belladonnæ, E. opii, E. plumbi, E. saponis.

3.—Diadermatic: For constitutional or systemic effects. Vehicle: Lanolin or plaster-mull. Official plasters: Emp. hydrargyri.

Methods of Preparing Rubber Plasters.—Mechanic Roller Pressure Method.—This method of incorporating the rubber with certain substances to give it the necessary body to serve as a vehicle is at present the only one employed. But since it requires the use of the heaviest machinery—some of the apparatus weighing many tons—and enormous steam power, its application for pharmaceutical purposes is out of the question.

As is well known, the process consists in: 1. Purification of the rubber by macerating and pressing it and removing foreign impurities by elutriating it with water. 2. Forming a homogeneous mass of the dried purified rubber by working it on heated revolving rollers and incorporating sufficient quantities of orris powder and oleoresins. 3. Incorporating the medicinal agent, i. e., belladonna extract, with the rubber mass by working it on warmed revolving rollers. 4. Spreading the prepared plaster.

Solution in Volatile Solvents.—This process has been recommended from time to time, the principal objection being the use of so relatively large quantities of inflammable solvents.

The German Pharmacopœia Method.

—The following is the formula of "Arzneibuch für das Deutsche Reich," 1900: Emplastrum adhesivum: Lead plaster, waterfree, 40 parts; petrolatum, 2.5 parts; liquid petrolatum, 2.5 parts, are melted together, and to the mixture add rosin, 35 parts; dammar, 10 parts, previously melted. To the warm mixture is added caoutchouc, 10 parts; dissolved in benzine, 75 parts, and the mixture stirred on the water-bath until all the benzine is lost by evaporation.

The Coleplastrum adhesivum of the Austrian Society is still more complex, the formula containing the following: Rosin oil, empyreumatic, 150 parts; copaiba, 100 parts; rosin, 100 parts; lard, 50 parts; wax, 30 parts; dissolved in ether, 1,200 parts, in which caoutchouc, 250 parts, has been previously dissolved; to this

is then added orris powder, 220 parts; sandarac, 50 parts; ether, 400 parts. The mixture, when uniform, is spread on cloth.

Solution of Rubber in Fixed Solvent; Petrolatum and Incorporation with Lead Acetate.—India rubber dissolves, though with difficulty, in petrolatum. The heat required to melt the rubber being comparatively high, usually considerably more than 212° F., as stated in the U. S. P., it is necessary to melt the rubber first and then add the petrolatum, in order to avoid subjecting the latter to the higher temperature. The mixture of equal parts of rubber and petrolatum is of a soft jelly consistence, not especially adhesive, but when incorporated with the lead oleate furnishes a very adhesive plaster. While at first 5 per cent of each rubber and petrolatum was used, it has been found that the petrolatum would melt and exude around the edges of the plaster when applied to the skin, and the quantity was therefore reduced to 2 per cent of each. This mass affords a plaster which is readily adhesive to the body, does not run nor become too soft. Plasters spread on cloth have been kept for months exposed to the sun in the summer weather without losing their stability or permanency.

The lead oleate made by the interaction of hot solution of soap and lead acetate, thoroughly washed with hot water, and freed from water by working the precipitated oleate on a hot tile, is much to be preferred to the lead plaster made by the present official process. The time-honored method of boiling litharge, olive oil, and water is for the requirements of the pharmacists most tedious and unsatisfactory. Since in the beginning of the process, at least, a temperature higher than that of 212° F. is required, the water bath cannot be employed, and in the absence of this limiting device the product is usually "scorched." When the steam bath under pressure can be used this objection does not apply. But the boiling process requires from 3 to 4 hours, with more or less attention, while the precipitation method does not take over half an hour. Besides, true litharge is difficult to obtain, and any other kind will produce unsatisfactory results.

The following is the process employed:

Lead oleate (Emplastrum plumbi):
Soap, granular and
dried..... 100 parts
Lead acetate..... 60 parts
Distilled water, a sufficient quantity.

Dissolve the soap in 350 parts hot distilled water and strain the solution. Dissolve the lead acetate in 250 parts hot distilled water and filter the solution while hot into the warm soap solution, stirring constantly. When the precipitate which has formed has separated, decant the liquid and wash the precipitate thoroughly with hot water. Remove the precipitate, let it drain, free from water completely by kneading it on a warm slab, form it into rolls, wrap in paraffine paper, and preserve in tightly closed containers.

Emplastrum adhesivum:

Rubber, cut in small pieces.....	20 parts
Petrolatum.....	20 parts
Lead plaster.....	960 parts

Melt the rubber at a temperature not exceeding 302° F., add the petrolatum, and continue the heat until the rubber is dissolved. Add the lead plaster to the hot mixture, continue the heat until it becomes liquid; then let it cool and stir until it stiffens.

Court Plaster or Sticking Plaster.—I.

—Brush silk over with a solution of isinglass, in spirits or warm water, dry and repeat several times. For the last application apply several coats of balsam of Peru. This is used to close cuts or wounds, by warming and applying it. It does not wash off until the skin partially heals.

II.—Isinglass, 1 part; water, 10 parts; dissolve, strain the solution, and gradually add to it of tincture of benzoin, 2 parts; apply this mixture gently warmed, by means of a camel's-hair brush, to the surface of silk or sarcenet, stretched on a frame, and allow each coating to dry before applying the next one, the application being repeated as often as necessary; lastly, give the prepared surface a coating of tincture of benzoin or tincture of balsam of Peru. Some manufacturers apply this to the unprepared side of the plaster, and others add to the tincture a few drops of essence of ambergris or essence of musk.

III. (Deschamps).—A piece of fine muslin, linen, or silk is fastened to a flat board, and a thin coating of smooth, strained flour paste is given to it; over this, when dry, two coats of colorless gelatin, made into size with water, quantity sufficient, are applied warm. Said to be superior to the ordinary court plaster.

Coloring of Modeling Plaster.—I.—If burnt gypsum is stirred up with water con-

taining formaldehyde and with a little alkali, and the quantity of water necessary for the induration of the plaster containing in solution a reducible metallic salt is added thereto, a plaster mass of perfectly uniform coloring is obtained. The hardening of the plaster is not affected thereby. According to the concentration of the metallic salt solutions and the choice of the salts, the most varying shades of color, as black, red, brown, violet, pearl gray, and bronze may be produced. The color effect may be enhanced by the addition of certain colors. For the production of a gray-colored gypsum mass, for example, the mode of procedure is as follows: Stir 15 drachms of plaster with one-fourth its weight of water, containing a few drops of formaldehyde and a little soda lye and add 10 drops of a one-tenth normal silver solution, which has previously been mixed with the amount of water necessary for hardening the gypsum. The mass will immediately upon mixing assume a pearl-gray shade, uniform throughout. In order to produce red or copper-like, black or bronze-like shades, gold salts, copper salts or silver salts, bismuth salts or lead salts, singly or mixed, are used. Naturally, these colorings admit of a large number of modifications. In lieu of formaldehyde other reducing agents may be employed, such as solutions of sulphurous acid or hydrogen peroxide with a little alkali. Metals in the elementary state may likewise be made use of, e. g., iron, which, stirred with a little copper solution and plaster, produces a brown mass excelling in special hardness, etc. This process of coloring plaster is distinguished from the former methods in that the coloration is caused by metals in the nascent state and that a very fine division is obtained. The advantage of the dyeing method consists in that colorings can be produced with slight quantities of a salt; besides, the fine contours of the figures are in no way affected by this manner of coloring, and another notable advantage lies in the mass being colored throughout, whereby a great durability of the color against outside actions is assured. Thus a peeling off of the color or other way of becoming detached, such as by rubbing off, is entirely excluded.

II.—Frequently, in order to obtain colored plaster objects, ochre or powdered colors are mixed with the plaster. This method leaves much to be desired, because the mixture is not always perfect, and instead of the expected uniform color, blotches appear. Here is a more

certain recipe: Boil brazil wood, log-wood, or yellow wood, in water, according to the desired color, or use extracts of the woods. When the dye is cold mix it with the plaster. The dye must be passed through a cloth before use. One may also immerse the plaster articles, medals, etc., in this dye, but in this case they must be left for some time and the operation repeated several times.

Treatment of Fresh Plaster.—Freshly plastered cement surfaces on walls may be treated as follows:

The freshly plastered surface first remains without any coating for about 14 days; then it is coated with a mixture of 50 parts water and 10 parts ammonia carbonate dissolved in hot water; leave this coat alone for a day, paint it again and wait until the cement has taken on a uniform gray color, which takes place as a rule in 12 to 14 days. Then prime the surface thus obtained with pure varnish and finish the coating, after drying, with ordinary varnish paint or turpentine paint.

Plaster for Foundry Models.—Gum lac, 1 part; wood spirit, 2 parts; lamp-black in sufficient quantity to dye.

Plaster from Spent Gas Lime.—Spent lime from gas purifiers, in which the sulphur has been converted into calcium sulphate, by exposure to weather, if necessary, is mixed with clay rich in alumina. The mixture is powdered, formed into balls or blocks with water, and calcined at a temperature below that at which the setting qualities of calcium sulphate are destroyed. Slaked lime, clay, and sand are added to the calcined product, and the whole is finely powdered.

Plaster Mold.—Nearly all fine grades of metals can be cast in plaster molds, provided only a few pieces of the castings are wanted. Dental plaster should be used, with about one-half of short asbestos. Mix the two well together, and when the mold is complete let it dry in a warm place for several days, or until all the moisture is excluded. If the mold is of considerable thickness it will answer the purpose better. When ready for casting, the plaster mold should be warmed, and smoked over a gas light; then the metal should be poured in, in as cool a state as it will run.

Cleaning of Statuettes and Other Plaster Objects.—Nothing takes the dust more freely than plaster objects, more or less artistic, which are the modest ornaments of our dwellings. They rapidly

contract a yellow-gray color, of unpleasant appearance. Here is a practical method for restoring the whiteness: Take finely powdered starch, quite white, and make a thick paste with hot water. Apply, when still hot, with a flexible spatula or a brush on the plaster object. The layer should be quite thick. Let it dry slowly. On drying, the starch will split and scale off. All the soiled parts of the plaster will adhere, and be drawn off with the scales. This method of cleaning does not detract from the fineness of the model.

Hardening and Toughening Plaster of Paris.—I.—Plaster of Paris at times sets too rapidly; therefore the following recipe for toughening and delaying drying will be useful. To calcined plaster of Paris add 4 per cent of its weight of powdered marshmallow root, which will keep it from setting for about an hour, and augment its hardness when set, or double the quantity of marshmallow root powder, and the plaster will become very firm, and may be worked 2 or 3 hours after mixing, and may be carved and polished when hard. It is essential that these powders, which are of different densities and specific gravities, should be thoroughly mixed, and the plaster of Paris be quite fresh, and it must be passed through fine hair sieves to ensure its being an impalpable powder. To ensure thorough mixing, pass the combined powders through the hair sieve three times. Make up with water sufficient for the required model or models. Should any of the powder be left over it may be kept by being put in an air-tight box and placed in a warm room.

The marshmallow root powder may be replaced by dextrin, gum arabic, or glue. The material treated is suitable while yet in a soft state, for rolling, glass-tube developing, making plates, etc.

II.—Plaster of Paris may be caused to set more quickly if some alum be dissolved in the water used for rendering it plastic. If the gypsum is first moistened with a solution of alum and then again burned, the resulting compound sets very quickly and becomes as hard as marble. Borax may be similarly employed. The objects may also be treated with a solution of caustic baryta. But it has been found that no matter how deep this penetrates, the baryta is again drawn toward the surface when the water evaporates, a portion efflorescing on the outside, and only a thin layer remaining in the outer shell, where it is converted into carbonate. This at the same time

stops up the pores, rendering it impossible to repeat the operation. It was later found that the whole mass of the cast might be hardened by applying to it with a brush made of glass bristles, a hot solution of baryta. To prevent separation of the crystallized baryta at the surface, the object must be raised to a temperature of 140° to 175° F. To produce good results, however, it is necessary to add to the plaster before casting certain substances with which the baryta can combine. These are silicic acid in some form, or the sulphates of zinc, magnesium, copper, iron, aluminum, etc. With some of these the resulting object may be colored. As it is, however, difficult to insure the production of uniform tint, it is better when employing salts producing color, to mix the plaster with about 5 per cent of quicklime, or, better, to render it plastic with milk of lime, and then to soak the object in a solution of metallic sulphate.

Preservation of Plaster Casts.—Upon complete drying, small objects are laid for a short while in celluloid varnish of 4 per cent, while large articles are painted with it, from the top downward, using a soft brush. Articles set up outside and exposed to the weather are not protected by this treatment, while others can be readily washed off and cleaned with water. To cover 100 square feet of surface, 1½ pints of celluloid varnish are required.

To Arrest the Setting of Plaster of Paris.—Citric acid will delay the setting of plaster of Paris for several hours. One ounce of acid, at a cost of about 5 cents, will be sufficient to delay the setting of 100 pounds of plaster of Paris for 2 or 3 hours. Dissolve the acid in the water before mixing the plaster.

Weatherproofing Casts.—I.—Brethauer's method of preparing plaster of Paris casts for resisting the action of the weather is as follows: Slake 1 part of finely pulverized lime to a paste, then mix gypsum with limewater and intimately mix both. From the compound thus prepared the figures are cast. When perfectly dry they are painted with hot linseed oil, repeating the operation several times, then with linseed-oil varnish, and finally with white oil paint. Statues, etc., prepared in this way have been constantly exposed to the action of the weather for 4 years without suffering any change.

II.—Jacobsen prepares casts which retain no dust, and can be washed with

lukewarm soap water by immersing them or throwing upon them in a fine spray a hot solution of a soap prepared from stearic acid and soda lye in ten times its quantity, by weight, of hot water.

Reproduction of Plaster Originals.—This new process consists in making a plaster mold over the original in the usual manner. After the solidification of the plaster the mass of the original is removed, as usual, by cutting out and rinsing out. The casting mold thus obtained is next filled out with a ceramic mass consisting of gypsum, 1 part; powdered porcelain, 5 parts; and flux, 1 part. After the mass has hardened it is baked in the mold. This renders the latter brittle and it falls apart on moistening with water while the infusion remains as a firm body, which presents all the details of the original in a true manner.

PLASTIC WOOD:

Xylol	1 quart
Acetone	1¼ pints
Ethyl acetate	1 pint
Castor oil	6 drams
Celluloid	1½ pounds
	avoirdupois

Wood flour Enough

Mix first three items, add castor oil and the celluloid, allow the celluloid to dissolve. Then add enough wood flour to make a thick paste. If too thick then thin with xylol. Keep solvents away from open flame as they are very inflammable. Keep in cans, so as not to evaporate.

When plastic wood has been kept for a long time it hardens. To soften it again add a little acetone and replace cover on can.

Plating

The plating of metal surfaces is accomplished in four different ways: (1) By oxidation, usually involving dipping in an acid bath; (2) by electrodeposition, involving suspension in a metallic solution, through which an electric current is passed; (3) by applying a paste that is fixed, as by burning in; (4) by pouring on molten plating metal and rolling. For convenience the methods of plating are arbitrarily classified below under the following headings:

1. Bronzing.
2. Coloring of Metals.
3. Electrodeposition Processes.
4. Gilding and Gold-Plating.

5. Oxidizing Processes.
6. Patina Oxidizing Processes.
7. Platinizing.
8. Silvering and Silver-Plating.
9. Tinned Lead-Plating.
10. Various Recipes.

BRONZING:

Art Bronzes.—These are bronzes of different tints, showing a great variety according to the taste and fancy of the operator.

I.—After imparting to an object a coating of vert antique, it is brushed to remove the verdigris, and another coat is applied with the following mixture: Vinegar, 1,000 parts, by weight; powdered bloodstone, 125 parts, by weight; plumbago, 25 parts, by weight. Finish with a waxed brush and a coat of white varnish.

II.—Cover the object with a mixture of vinegar, 1,000 parts, by weight; powdered bloodstone, 125 parts, by weight; plumbago, 25 parts, by weight; sal ammoniac, 32 parts, by weight; ammonia, 32 parts, by weight; sea salt, 32 parts, by weight. Finish as above.

Antique Bronzes.—In order to give new bronze castings the appearance and patina of old bronze, various compositions are employed, of which the following are the principal ones:

I.—Vert Antique: Vinegar, 1,000 parts, by weight; copper sulphate, 16 parts, by weight; sea salt, 32 parts, by weight; sal ammoniac, 32 parts, by weight; mountain green (Sanders green), 70 parts, by weight; chrome yellow, 30 parts, by weight; ammonia, 32 parts, by weight.

II.—Vert Antique: Vinegar, 1,000 parts, by weight; copper sulphate, 16 parts, by weight; sea salt, 32 parts, by weight; sal ammoniac, 32 parts, by weight; mountain green, 70 parts, by weight; ammonia, 32 parts, by weight.

III.—Dark Vert Antique: To obtain darker vert antique, add a little plumbago to the preceding mixtures.

IV.—Vinegar, 1,000 parts, by weight; sal ammoniac, 8 parts, by weight; potassium binoxalate, 1 part, by weight.

Brass Bronzing.—**I.**—Immerse the articles, freed from dirt and grease, into a cold solution of 10 parts of potassium permanganate, 50 parts of iron sulphate, 5 parts of hydrochloric acid, in 1,000 parts of water. Let remain 30 seconds; then withdraw, rinse off, and dry in fine, soft sawdust. If the articles have be-

come too dark, or if a reddish-brown color be desired, immerse for about 1 minute into a warm (60° C. or 140° F.) solution of chromic acid, 10 parts; hydrochloric acid, 10 parts; potassium permanganate, 10 parts; iron sulphate, 50 parts; water, 1,000 parts. Treat as before. If the latter solution alone be used the product will be a brighter dark yellow or reddish-brown color. By heating in a drying oven the tone of the colors is improved.

II.—Rouge, with a little chloride of platinum and water, will form a chocolate brown of considerable depth of tone and is exceedingly applicable to brass surfaces which are to resemble a copper bronze.

Copper Bronzing.—**I.**—After cleaning the pieces, a mixture made as follows is passed over them with a brush: Castor oil, 20 parts; alcohol, 80 parts; soft soap, 40 parts; water, 40 parts. The day after application, the piece has become bronzed; and if the time is prolonged, the tint will change. Thus, an affinity of shades agreeable to the eye can be procured. The piece is dried in hot sawdust, and colorless varnish with large addition of alcohol is passed over it. This formula for bronzing galvanic apparatus imparts any shade desired, from Barbodienne bronze to antique green, provided the liquid remains for some time in contact with the copper.

II.—Acetate of copper, 6 parts; sal ammoniac, 7 parts; acetic acid, 1 part; distilled water, 100 parts. Dissolve all in water in an earthen or porcelain vessel. Place on the fire and heat slightly; next, with a brush give the objects to be bronzed 2 or 3 coats, according to the shade desired. It is necessary that each coat be thoroughly dry before applying another.

Bronzing of Gas Fixtures.—Gas fixtures which have become dirty or tarnished from use may be improved in appearance by painting with bronze paint and then, if a still better finish is required, varnishing after the paint is thoroughly dry with some light-colored varnish that will give a hard and brilliant coating.

If the bronze paint is made up with ordinary varnish it is liable to become discolored from acid which may be present in the varnish. One method proposed for obviating this is to mix the varnish with about 5 times its volume of spirit of turpentine, add to the mixture dried slaked lime in the proportion of about 40 grains to the pint, agitate well,

repeating the agitation several times, and finally allowing the suspended matter to settle and decanting the clear liquid. The object of this is, of course, to neutralize any acid which may be present. To determine how effectively this has been done, the varnish may be chemically tested.

Iron Bronzing.—I.—The surface of a casting previously cleaned and polished is evenly painted with a vegetable oil, e. g., olive oil, and then well heated, care being taken that the temperature does not rise to a point at which the oil will burn. The cast iron absorbs oxygen at the moment when the decomposition of the oil begins, and a brown layer of oxide is formed which adheres firmly to the surface and which may be vigorously polished, giving a bronze-like appearance to the surface of the iron.

II.—To give polished iron the appearance of bronze commence by cleaning the objects, then subject them for about 5 minutes to the vapor of a mixture of concentrated hydrochloric and nitric acids; then smear them with vaseline and heat them until the vaseline begins to decompose. The result is a fine bronzing.

Liquid for Bronze Powder.—Take 2 ounces gum animi and dissolve in $\frac{1}{2}$ pint linseed oil by adding gradually while the oil is being heated. Boil, strain, and dilute with turpentine.

Bronzing Metals.—I.—The following composition is recommended for bronzing metal objects exposed to the air: Mix about equal parts of siccative, rectified oil of turpentine, caoutchouc oil, and dammar varnish, and apply this composition on the objects, using a brush. This bronze has been found to resist the influences of the weather.

II.—Cover the objects with a light layer of linseed oil, and then heat over a coal fire, prolonging the heat until the desired shade is reached.

III.—Expose the objects to be bronzed for about 5 minutes to the vapors of a bath composed of 50 parts of nitric acid and 50 parts of concentrated hydrochloric acid. Then rub the articles with vaseline and heat until the vaseline is decomposed. The objects to be bronzed must always be perfectly polished.

IV.—To bronze iron articles they should be laid in highly heated coal dust; the articles must be covered up in the glowing dust, and the heat must be the same throughout. The iron turns at

first yellow, then blue, and finally rather black. Withdraw the objects when they have attained the blue shade or the black color; then while they are still hot, rub them with a wad charged with tallow.

V.—For electrolytic bronzing of metals the baths employed differ from the brass baths only in that they contain tin in solution instead of zinc. According to Elsner, dissolve 70 parts, by weight, of cupric sulphate in 1,000 parts of water and add a solution of 8 parts of stannic chloride in caustic lye. For a positive pole plate put in a bronze plate. The bath works at ordinary temperature.

VI.—A good bath consists of 10 parts of potash, 2 parts of cupric chloride, 1 part of tin salt, 1 part of cyanide of potassium dissolved in 100 parts of water.

VII.—Mix a solution of 32 parts of copper sulphate in 500 parts of water with 64 parts of cyanide of potassium. After the solution has become clear, add 4 to 5 parts of stannic chloride dissolved in potash lye.

VIII.—Precipitate all soda from a solution of blue vitriol by phosphate of sodium, wash the precipitate well, and dissolve in a concentrated solution of pyrophosphate of copper. Also, saturate a solution of the same salt with tin salt. Of both solutions add enough in such proportion to a solution of 50 parts, by weight, of pyrophosphate of sodium in 1,000 parts of water until the solution appears clear and of the desired color. A cast bronze plate serves as an anode. From time to time a little soda, or if the precipitate turns out too pale, copper solution should be added.

Tin Bronzing.—The pieces are well washed and all grease removed; next plunged into a solution of copperas (green vitriol), 1 part; sulphate, 1 part; water, 20 parts. When dry they are plunged again into a bath composed of verdigris, 4 parts; dissolved in distilled wine vinegar, 11 parts. Wash, dry, and polish with English red.

Zinc Bronzing.—The zinc article must be first electro-coppered before proceeding to the bronzing. The process used is always the same; the different shades are, however, too numerous to cover all of them in one explanation. The bronzing of zinc clocks is most frequently done on a brown ground, by mixing graphite, lampblack, and sanguine stirred in water in which a little Flanders Dutch glue is dissolved. The application is made by means of a brush. When it is dry a

spirit varnish is applied; next, before the varnish is perfectly dry, a little powdered bronze or sanguine or powdered graphite, mixed with sanguine or with graphite, according to the desired shades. For green bronze, mix green sanders with chrome yellow stirred with spirit in which a little varnish is put. When the bronzing is dry, put on the varnish and the powdered bronze as above described. After all has dried, pass the brush over a piece of wax, then over the bronzed article, being careful to charge the brush frequently with wax.

COLORING OF METALS:

Direct Coloration of Iron and Steel by Cupric Selenite.—Iron precipitates copper and selenium from their salts. Immersed in a solution of cupric selenite, acidulated with a few drops of nitric acid, it precipitates these two metals on its surface in the form of a dull black deposit, but slightly adherent. But, if the object is washed with water, then with alcohol, and rapidly dried over a gas burner, the deposit becomes adherent. If rubbed with a cloth, this deposit turns a blue black or a brilliant black, according to the composition of the bath.

The selenite of copper is a greenish salt insoluble in water, and but slightly soluble in water acidulated with nitric or sulphuric acid. It is preferable to mix a solution of cupric sulphate with a solution of selenious acid, and to acidulate with nitric acid, in order to prevent the precipitation of the selenite of copper.

This process, originated by Paul Malherbe, is quite convenient for blackening or bluing small objects of iron or steel, such as metallic pens or other small pieces. It does not succeed so well for objects of cast iron; and the selenious acid is costly, which is an obstacle to its employment on large metallic surfaces.

The baths are quickly impoverished, for insoluble yellow selenite of iron is deposited.

Brilliant Black Coloration.—Selenious acid, 6 parts; cupric sulphate, 10 parts; water, 1,000 parts; nitric acid, 4 to 6 parts.

Blue-Black Coloration.—Selenious acid, 10 parts; cupric sulphate, 10 parts; water, 1,000 parts; nitric acid, 4 to 6 parts.

By immersing the object for a short time the surface of the metal can be colored in succession yellow, rose, purple, violet and blue.

Coloration of Copper and Brass with Cupric Selenite.—When an object of copper or brass is immersed in a solution of selenite of copper acidulated with

nitric acid, the following colors are obtained, according to the time of the immersion: Yellow, orange, rose, purple, violet, and blue, which is the last color, which can be obtained. In general, the solution should be slightly acid; otherwise the color is fugacious and punctate.

	a.	b.
Selenious acid	6.5	2.9 parts
Sulphate of copper	12.5	20.0 parts
Nitric acid	2.0	2.5 parts
Water	1,000.0	1,000.0 parts

Production of Rainbow Colors on Metals (iron, copper, brass, zinc, etc.)—

I.—The following process of irisation is due to Puschner. It allows of covering the metals with a thick layer of metallic sulphide, similar to that met with in nature—in galena, for example.

These compounds are quite solid and are not attacked by concentrated acids and alkalis, while dilute reagents are without action. In 5 minutes thousands of objects of brass can be colored with the brightest hues. If they have been previously cleaned chemically, the colors deposited on the surface adhere with such strength that they can be worked with the burnisher.

Forty-five parts of sodium hyposulphite are dissolved in 500 parts of water; a solution of 15 parts of neutral acetate of lead in 500 parts of water is poured in. The clear mixture, which is composed of a double salt of hyposulphite of lead and of sodium, possesses, when heated to 212° F., the property of decomposing slowly and of depositing brown flakes of lead sulphide. If an article of gold, silver, copper, brass, tombac, iron, or zinc is put into this bath while the precipitation is taking place, the object will be covered with a film of lead sulphide, which will give varied and brilliant colors, according to its thickness. For a uniform coloration, it is necessary that the pieces should be heated quite uniformly. However, iron assumes under this treatment only a blue color, and zinc a bronze color. On articles of copper the first gold color which appears is defective. Lead and tin are not colored.

By substituting for the neutral acetate of lead an equal quantity of cupric sulphate and proceeding in a similar way, brass or imitation gold is covered with a very beautiful red, succeeded by an imperfect green, and finally a magnificent brown, with iridescent points of greenish red. The latter coating is fairly permanent.

Zinc is not colored in this solution, and

precipitates in it a quantity of flakes of greenish brown (cupric sulphide), but if about one-third of the preceding solution of lead acetate is added, a solid black color is developed, which, when covered with a light coating of wax, gains much in intensity and solidity. It is also useful to apply a slight coating of wax to the other colors.

II.—Beautiful designs may be obtained, imitating marble, with sheets of copper plunged into a solution of lead, thickened by the addition of gum tragacanth, and heated to 212° F. Afterwards they are treated with the ordinary lead solution. The compounds of antimony, for example the tartrate of antimony and potash, afford similar colorations, but require a longer time for their development. The solutions mentioned do not change, even after a long period, and may be employed several times.

III.—By mixing a solution of cupric sulphate with a solution of sodium hyposulphite, a double hyposulphite of sodium and of copper is obtained.

If in the solution of this double salt an article of nickel or of copper, cleaned with nitric acid, then with soda, is immersed, the following colors will appear in a few seconds: Brilliant red, green, rose, blue, and violet. To isolate a color, it is sufficient to take out the object and wash it with water. The colors obtained on nickel present a moiré appearance, similar to that of silk fabrics.

IV.—Tin sulphate affords with sodium hyposulphite a double salt, which is reduced by heat, with production of tin sulphide. The action of this double salt on metallic surfaces is the same as that of the double salts of copper and lead. Mixed with a solution of cupric sulphate, all the colors of the spectrum will be readily obtained.

V.—Coloration of Silver.—The objects of copper or brass are first covered with a layer of silver, when they are dipped in the following solution at the temperature of 205° to 212° F.: Water, 3,000 parts; sodium hyposulphite, 300 parts; lead acetate, 100 parts.

VI.—Iron precipitates bismuth from its chlorhydric solution. On heating this deposit, the colors of the rainbow are obtained.

Coloration by Electrolysis.—I.—Colored Rings by Electrolysis (Nobili, Becquerel).—In order to obtain the Nobili rings it is necessary to concentrate the current coming from one of the poles of the battery through a platinum wire,

whose point alone is immersed in the liquid to be decomposed, while the other pole is connected with a plate of metal in the same liquid. This plate is placed perpendicularly to the direction of the wire, and at about 0.04 inches from the point.

Solutions of sulphate of copper, sulphate of zinc, sulphate of manganese, acetate of lead, acetate of copper, acetate of potassium, tartrate of antimony and potash, phosphoric acid, oxalic acid, carbonate of soda, chloride of manganese, and manganous acetate, may be employed.

II.—A process, due to M. O. Mathey, allows of coloring metals by precipitating on their surface a transparent metallic peroxide. The phenomenon of electrochemical coloration on metals is the same as that which takes place when an object of polished steel is exposed to heat. It first assumes a yellow color, from a very thin coating of ferric oxide formed on its surface. By continuing the heating, this coating of oxide increases in thickness, and appears red, then violet, then blue. Here, the coloration is due to the increase in the thickness of a thin coating of a metallic oxide precipitated by an alkaline solution.

The oxides of lead, tin, zinc, chromium, aluminum, molybdenum, tungsten, etc., dissolved in potash, may be employed; also protoxide of iron, zinc, cadmium, cobalt, dissolved in ammonia.

Lead Solution.—Potash, 400 parts; litharge or massicot, 125 parts. Boil 10 minutes, filter, dilute until the solution marks 25° Bé.

Iron Solution.—Dissolve ferrous sulphate in boiling water, and preserve sheltered from air. When desired for use, pour a quantity into a vessel and add ammonia until the precipitate is redissolved. This solution, oxidizing rapidly in the air, cannot be used for more than an hour.

III.—Electrochemical coloration succeeds very well on metals which are not oxidizable, such as gold and platinum, but not well on silver. This process is employed for coloring watch hands and screws. The object is placed at the positive pole, under a thickness of 1½ inches of the liquid, and the negative electrode is brought to the surface of the bath. In a few seconds all the colors possible are obtained. Generally, a ruby-red tint is sought for.

IV.—Coloration of Nickel.—The nickel piece is placed at the positive pole in a solution of lead acetate. A netting

of copper wires is arranged at the negative pole according to the contours of the design, and at a short distance from the object. The coloration obtained is uniform if the distance of the copper wires from the object is equal at all points.

Coloring of Brass.—I.—(a) Brown bronze: Acid solution of nitrate of silver and bismuth or nitric acid. (b) Light bronze: Acid solution of nitrate of silver and of copper. (c) Black: Solution of nitrate of copper. In all cases, however, the brass is colored black, if after having been treated with the acid solution, it is placed for a very short time in a solution of potassium sulphide, of ammonium sulphhydrate, or of hydrogen sulphide.

II.—The brass is immersed in a dilute solution of mercurous nitrate; the layer of mercury formed on the brass is converted into black sulphide, if washed several times in potassium sulphide. By substituting for the potassium sulphide the sulphide of antimony or that of arsenic, beautiful bronze colors are obtained, varying from light brown to dark brown.

III.—Clean the brass perfectly. Afterwards rub with sal ammoniac dissolved in vinegar. Strong vinegar, 1,000 parts; sal ammoniac, 30 parts; alum, 15 parts; arsenious anhydride, 8 parts.

IV.—A solution of chloride of platinum is employed, which leaves a very light coating of platinum on the metal, and the surface is bronzed. A steel tint or gray color is obtained, of which the shade depends on the metal. If this is burnished, it takes a blue or steel gray shade, which varies with the duration of the chemical action, the concentration, and the temperature of the bath. A dilute solution of platinum is prepared thus: Chloride of platinum, 1 part; water, 5,000 parts.

Another solution, more concentrated at the temperature of 104° F., is kept ready. The objects to be bronzed are attached to a copper wire and immersed for a few seconds in a hot solution of tartar, 30 parts to 5,000 parts of water. On coming from this bath they are washed 2 or 3 times with ordinary water, and a last time with distilled water, and then put in the solution of platinum chloride, stirring them from time to time. When a suitable change of color has been secured, the objects are passed to the concentrated solution of platinum chloride (40°). They are stirred, and taken out when the wished-for color has been reached. They are then washed 2 or 3 times, and dried in wood sawdust.

V.—To give to brass a dull black color, as that used for optical instruments, the metal is cleaned carefully at first, and covered with a very dilute mixture of neutral nitrate of tin, 1 part; chloride of gold, 2 parts. At the end of 10 minutes this covering is removed with a moist brush. If an excess of acid has not been employed, the surface of the metal will be found to be of a fine dull black.

The nitrate of tin is prepared by decomposing the chloride of this metal with ammonia and afterwards dissolving in nitric acid the oxide of tin formed.

VI.—For obtaining a deposit of bismuth the brass is immersed in a boiling bath, prepared by adding 50 to 60 parts of bismuth to nitric acid diluted with 1,000 parts of water, and containing 32 parts of tartaric acid.

VII.—The electrolysis of a cold solution of 25 to 30 parts per 1,000 parts of the double chloride of bismuth and ammonium produces on brass or on copper a brilliant adherent deposit of bismuth, whose appearance resembles that of old silver.

Production of Rainbow Hues.—Various colors.—I.—Dissolve tartrate of antimony and of potash, 30 parts; tartaric acid, 30 parts; water, 1,000 parts. Add hydrochloric acid, 90 to 120 parts; pulverized antimony, 90 to 120 parts. Immerse the object of brass in this boiling liquid, and it will be covered with a film, which, as it thickens, reflects quite a series of beautiful tints, first appearing iridescent, then the color of gold, copper, or violet, and finally of a grayish blue. These colors are adherent, and do not change in the air.

II.—The sulphide of tin may be deposited on metallic surfaces, especially on brass, communicating shades varying with the thickness of the deposit. For this purpose, Puscher prepares the following solutions: Dissolve tartaric acid, 20 parts, in water, 1,000 parts; add a salt of tin, 20 parts; water, 125 parts. Boil the mixture, allow it to repose, and filter. Afterwards pour the clear portion a little at a time, shaking continually, into a solution of hyposulphite of soda, 80 parts; water, 250 parts. On boiling, sulphide of tin is formed, with precipitation of sulphur. On plunging the pieces of brass in the liquid, they are covered, according to the period of immersion, with varied shades, passing from gold yellow to red, to crimson, to blue, and finally to light brown.

III.—The metal is treated with the

following composition: Solution A.—Cotton, well washed, 50 parts; salicylic acid, 2 parts, dissolved in sulphuric acid, 1,000 parts, and bichromate of potash, 100 parts. Solution B.—Brass, 20 parts; nitric acid, density 1.51, 350 parts; nitrate of soda, 10 parts. Mix the two solutions, and dilute with 1,500 parts of water. These proportions may be modified according to the nature of the brass to be treated. This preparation is spread on the metal, which immediately changes color. When the desired tint is obtained, the piece is quickly plunged in an alkaline solution; a soda salt, 50 parts; water, 1,000 parts. The article is afterwards washed, and dried with a piece of cloth. Beautiful red tins are obtained by placing the objects between 2 plates, or better yet, 2 pieces of iron wire-cloth.

IV.—Put in a flask 100 parts of cupric carbonate and 750 parts of ammonia and shake. This liquid should be kept in well-stoppered bottles. When it has lost its strength, this may be renewed by pouring in a little ammonia. The objects to be colored should be well cleaned. They are suspended in the liquid and moved back and forth. After a few minutes of immersion, they are washed with water and dried in wood sawdust. Generally, a deep-blue color is obtained.

V.—Plunge a sheet of perfectly clean brass in a dilute solution of neutral acetate of copper, and at the ordinary temperature, and in a short time it will be found covered with a fine gold yellow.

VI.—Immerse the brass several times in a very dilute solution of cupric chloride, and the color will be deadened and bronzed a greenish gray.

A plate of brass heated to 302° F. is colored violet by rubbing its surface gently with cotton soaked with cupric chloride.

VII.—On heating brass, perfectly polished, until it can be no longer held in the hand, and then covering it rapidly and uniformly with a solution of antimony chloride by means of a wad of cotton, a fine violet tint is communicated.

VIII.—For greenish shades, a bath may be made use of, composed of water, 100 parts; cupric sulphate, 8 parts; sal ammoniac, 2 parts.

IX.—For orange-brown and cinnamon-brown shades: Water, 1,000 parts; potassium chlorate, 10 parts; cupric sulphate, 10 parts.

X.—For obtaining rose-colored hues, then violet, then blue: Water, 400 parts; cupric sulphate, 30 parts; sodium hyposulphite, 20 parts; cream of tartar, 10 parts.

XI.—For yellow, orange, or rose-colored shades, then blue, immerse the objects for a longer or shorter time in the following bath: Water, 400 parts; ammoniacal ferrous sulphate, 20 parts; sodium hyposulphite, 40 parts; cupric sulphite, 30 parts; cream of tartar, 10 parts. By prolonging the boiling, the blue tint gives place to yellow, and finally to a fine gray.

XII.—A yellowish brown may be obtained with water, 50 parts; potassium chlorate, 5 parts; nickel carbonate, 2 parts; sal nickel, 5 parts.

XIII.—A dark brown is obtained with water, 50 parts; sal nickel, 10 parts; potassium chlorate, 5 parts.

XIV.—A yellowish brown is obtained with water, 350 parts; a crystallized sodium salt, 10 parts; orpiment, 5 parts.

XV.—Metallic moire is obtained by mixing two liquids: (a) Cream of tartar, 5 parts; cupric sulphate, 5 parts; water, 250 parts. (b) Water, 125 parts; sodium hyposulphite, 15 parts.

XVI.—A beautiful color is formed with one of the following baths: (a) Water, 140 parts; ammonia, 5 parts; potassium sulphide, 1 part. (b) Water, 100 parts; ammonium sulphhydrate, 2 parts.

Bronzing of Brass.—The object is boiled with zinc grains and water saturated with ammoniacal chlorhydrate. A little zinc chloride may be added to facilitate the operation, which is completed as above.

It may also be terminated by plunging the object in the following solution: Water, 2,000 parts; vinegar, 100 parts; sal ammoniac, 475 parts; pulverized verdigris, 500 parts.

ELECTRODEPOSITION PROCESSES.

The electrodeposition process is that used in electroplating and electrotyping. It consists in preparing a bath in which a metal salt is in solution, the articles to be plated being suspended so that they hang in the solution, but are insulated. The bath being provided with an anode and cathode for the passing of an electric current, and the article being connected with the cathode or negative pole, the salts are deposited on its surface (on the unprotected parts of its surface), and thus receive a coating or plating of the metal in solution.

When a soft metal is deposited upon a hard metal or the latter upon a metal softer than itself, the exterior metal should be polished and not burnished, and for this reason: If silver is deposited upon lead, for instance, the great pressure which is required in burnishing to produce the necessary polish would cause the softer metal to expand, and consequently a separation of the two metals would result. On the other hand, silver being softer than steel, if the burnisher is applied to silver-coated steel the exterior metal will expand and separate from the subjacent metal.

Many articles which are to receive deposits require to have portions of their surfaces topped off, to prevent the deposit spreading over those parts; for instance, in taking a copy of one side of a bronze medallion, the opposite side must be coated with some kind of varnish, wax, or fat, to prevent deposition; or, in gilding the inside of a cream jug which has been silvered on the outside, varnish must be applied all around the outer side of the edge, for the same reason. For gilding and other hot solutions, copal varnish is generally used; but for cold liquids and common work, an ordinary varnish, such as engravers use for similar purposes, will do very well. In the absence of other substances, a solution of sealing wax, dissolved in naphtha, may be employed.

Plating of Aluminum.—The light metal may be plated with almost any other metal, but copper is most commonly employed. Two formulas for coppering aluminum follow:

I.—Make a bath of cupric sulphate, 30 parts; cream of tartar, 30 parts; soda, 25 parts; water, 1,000 parts. After well scouring the objects to be coppered, immerse in the bath. The coppering may also be effected by means of the battery with the following mixture: Sodium phosphate, 50 parts; potassium cyanide, 50 parts; copper cyanide, 50 parts; distilled water, 1,000 parts.

II.—First clean the aluminum in a warm solution of an alkaline carbonate, thus making its surface rough and porous; next wash it thoroughly in running water, and dip it into a hot solution of hydrochloric acid of about 5 per cent strength. Wash it again in clean water, and then place it in a somewhat concentrated acid solution of copper sulphate, until a uniform metallic deposit is formed; it is then again thoroughly washed and returned to the copper sulphate bath, when an electric current is

passed until a coating of copper of the required thickness is obtained.

Brassing.—The following recipe is recommended for the bath: Copper acetate, 50 parts, by weight; dry zinc chloride, 25 parts, by weight; crystallized sodium sulphite, 250 parts, by weight; ammonium carbonate, 35 parts, by weight; potassium cyanide, 110 parts, by weight. Dissolve in 3,000 parts of water.

Coppering.—I.—This is the Dessolle process for the galvanic application of copper. The special advantage claimed is that strong currents can be used, and a deposit obtained of 0.004 inch in 1½ hours. After having cleaned the object to be coppered, with sand or in an acid bath, a first coat is deposited in an ordinary electrolytic bath; then the object is placed in a final bath, in which the electrolyte is projected on the electrode, so as to remove all bubbles of gas or other impurities tending to attach themselves to the surface. The electrolyte employed is simply a solution of cupric sulphate in very dilute sulphuric acid. For the preliminary bath the double cyanide of potassium and copper is made use of.

II.—Those baths which contain cyanide work best, and may be used for all metals. The amount of the latter must not form too large an excess. The addition of a sulphide is very dangerous. It is of advantage that the final bath contain an excess of alkali, but only as ammonia or ammonium carbonate. For a copper salt the acetate is preferable. According to this, the solution A is prepared in the warm, and solution B is added with heating. Solution A: Neutral copper acetate, 30 parts, by weight; crystallized sodium sulphite, 30 parts, by weight; ammonium carbonate, 5 parts, by weight; water, 500 parts, by weight. Solution B: Potassium cyanide (98 to 99 per cent), 35 parts, by weight; and water, 500 parts, by weight.

Coppering Glass.—I.—Glass vessels may be coated with copper by electrolytic process, by simply varnishing the outer surface of the vessel, and when the varnish is nearly dry, brushing plumbago well over it. A conducting wire is then attached to the varnished surface, which may be conveniently done by employing a small piece of softened gutta percha or beeswax, taking care to employ the plumbago to the part which unites the wire to the plumbagoed surface.

II.—Dissolve gutta percha in essence of turpentine or benzine; apply a coat of the solution on the glass in the places to

be coppered and allow to dry; next rub it with graphite and place in the electric bath. The rubber solution is spread with a brush.

Coppering Plaster Models, etc.—Busts and similar objects may be coated by saturating them with linseed oil, or better, with beeswax, then well blackleading, or treating them with phosphorous, silver and gold solutions, attaching a number of guiding wires, connected with all the most hollow and distant parts, and then immersing them in the sulphate of copper solution and causing just sufficient copper to be deposited upon them, by the battery process, to protect them, but not to obliterate the fine lines or features.

Coppering Zinc Plate.—The zinc plate should first be cleaned with highly diluted hydrochloric acid and the acid completely removed with water. Then prepare an ammoniacal copper solution from 3 parts copper sulphate, 3 parts spirits of sal ammoniac, and 50 parts water. If possible the zinc articles are dipped into this solution or else the surface is coated a few times quickly and uniformly with a flat, soft brush, leaving to dry between the coats. When sufficient copper has precipitated on the zinc, brush off the object superficially.

Cobaltizing of Metals.—Following are various processes for cobaltizing on copper or other metals previously coppered:
I.—Cobalt, 50 parts, by weight; sal ammoniac, 25 parts; liquid ammonia, 15 parts; distilled water, 1,000 parts. Dissolve the cobalt and the sal ammoniac in the distilled water, and add the liquid ammonia.

II.—Pure potash in alcohol, 50 parts, by weight; cobalt chloride, 10 parts; distilled water, 1,000 parts. Dissolve the cobalt in half the distilled water and the potash in the other half and unite the two.

III.—Potassium sulphocyanide, 13 parts, by weight; cobalt chloride, 10 parts; pure potash in alcohol, 2 parts; distilled water, 1,000 parts. Proceed as described above. All these baths are used hot and require a strong current.

Nickel Plating with the Battery.—The nickel bath is prepared according to the following formula:

I.—Nickel and ammonium sulphate... 10 parts
Boracic acid... 4 parts
Distilled water... 175 parts
A sheet of nickel is used as an anode.

Perfect cleanliness of the surface to be coated is essential to success. With nickel especially is this the case, as traces of oxide will cause it to show dark streaks. Finger marks will in any case render the deposit liable to peel off.

Cleansing is generally accomplished either by boiling in strong solution of potassium hydrate, or, when possible, by heating to redness in a blow-pipe flame to burn off any adhesive grease, and then soaking in a pickle of dilute sulphuric acid to remove any oxide formed during the heating. In either case it is necessary to subject the article to a process of scratch brushing afterwards; that is, long-continued friction with wire brushes under water, which not only removes any still adhering oxide, but renders the surface bright.

To certain metals, as iron, nickel, and zinc, metallic deposits do not readily adhere. This difficulty is overcome by first coating them with copper in a bath composed as follows:

II.—Potassium cyanide. 2 parts
Copper acetate, in crystals..... 2 parts
Sodium carbonate, in crystals..... 2 parts
Sodium bisulphite .. 2 parts
Water..... 100 parts

Moisten the copper acetate with a small quantity of water and add the sodium carbonate dissolved in 20 parts of water. When reaction is complete, all the copper acetate being converted into carbonate, add the sodium bisulphite, dissolved in another 20 parts of water; lastly, add the potassium cyanide, dissolved in the remainder of the water. The finished product should be a colorless liquid.

If a dynamo is not available for the production of a current, a Daniell's battery is to be recommended, and the "tank" for a small operation may be a glass jar. The jar is crossed by copper rods in connection with the battery; the metal to be deposited is suspended from the rod in connection with the positive pole, and is called the anode. The articles to be coated are suspended by thin copper wires from the rod in connection with the negative pole; these form the cathode. The worker should bear in mind that it is very difficult to apply a thick coating of nickel without its peeling.

Replating with Battery.—It is well known to electro-metallurgists that metals deposited by electricity do not adhere so firmly to their kind as to other metals. Thus gold will adhere more tenaciously to silver, copper, or brass, than it will to gold or to a gilt surface, and silver will attach itself more closely to copper or brass than to a silver-plated surface. Consequently, it is the practice to remove, by stripping or polishing the silver from old plated articles before electroplating them. If this were not done, the deposited coating would in all probability "strip," as it is termed, when the burnisher is applied to it—that is, the newly deposited metal would peel off the underlying silver.

Silver Plating.—The term silver deposit designates a coating of silver which is deposited upon glass, porcelain, china, or other substances. This deposit may be made to take the form of any desired design, and to the observer it has the appearance (in the case of glass) of having been melted on.

Practically all of the plated articles are made by painting the design upon the glass or other surface by means of a mixture of powdered silver, a flux and a liquid to make the mixture in the form of a paint so that it may be readily spread over the surface. This design is then fired in a muffle until the flux melts and causes the silver to become firmly attached to the glass. A thin silver deposit is thus produced, which is a conductor of electricity, and upon which any thickness of silver deposit may be produced by electroplating in the usual cyanide silver-plating bath.

To be successful in securing a lasting deposit a suitable flux must be used. This flux must melt at a lower temperature than the glass upon which it is put, in order to prevent the softening of the articles by the necessary heat and the accompanying distortion. Second, a suitable muffle must be had for firing the glass articles upon which the design has been painted. Not only must a muffle be used in which the heat can be absolutely controlled, but one which allows the slow cooling of the articles. If this is not done they are apt to crack while cooling.

The manufacture of the flux is the most critical part of the silver deposit process. Without a good flux the operation will not be a success. This flux is frequently called an enamel or frit. After a series of experiments it was found that the most suitable flux is a

borate of lead. This is easily prepared, fuses before the glass softens, and adheres tenaciously to the glass surface.

To make it, proceed as follows: Dissolve $\frac{1}{2}$ pound of acetate of lead (sugar of lead) in 1 quart of water and heat to boiling. Dissolve $\frac{1}{2}$ pound of borax in 1 quart of hot water and add to the sugar of lead solution. Borate of lead follows as a white precipitate. This is filtered out and washed until free from impurities. It is then dried.

The precipitated borate of lead is then melted in a porcelain or clay crucible. When in the melted condition it should be poured into a basin of cold water. This serves to granulate and render it easily pulverized. After it has been poured into water it is removed and dried. Before using in the paint it is necessary that this fused borate of lead be ground in a mortar as fine as possible. Unless this is done the deposit will not be smooth.

The silver to be used should be finely powdered silver, which can be purchased in the same manner as bronze powders.

The mixture used for painting the design upon the glass is composed of 2 parts of the powdered silver, and 1 part of the fused borate of lead. Place the parts in a mortar and add just enough oil of lavender to make the mass of a paint-like consistency. The whole is then ground with the pestle until it is as fine as possible. The amount of oil of lavender which is used must not be too great, as it will then be found that a thick layer cannot be obtained upon the glass.

The glass to be treated must be cleaned by scouring with wet pumice stone and washing soda. The glass should be rinsed and dried. The design is then painted on the glass with a brush, painting as thick as possible and yet leaving a smooth, even surface. The glass should be allowed to dry for 24 hours, when it is ready for firing.

When placed in the gas muffle, the glass should be subjected to a temperature of a very low red heat. The borate of lead will melt at this temperature, and after holding this heat a short time to enable the borate of lead to melt and attach itself, the muffle is allowed to cool.

After cooling, the articles are removed and scratch brushed and placed in a silver bath for an electro deposit of silver of a thickness desired.

Before the plating the glass article is dipped into a cyanide dip, or, if found necessary, scoured lightly with pumice

stone and cyanide, and then given a dip in the customary blue dip or mercury solution, so as to quickly cover all parts of the surface. It next passes to the regular cyanide silver solution, and is allowed to remain until the desired deposit is obtained.

A little potassium cyanide and some mono-basic potassium citrate in powder form is added from time to time to the bath generally used, which is prepared by dissolving freshly precipitated silver cyanide in a potassium cyanide solution. After this the glass is rinsed and dried, and may be finished by buffing.

Steel Plating.—The following is a solution for dipping steel articles before electroplating: Nitrate of silver, 1 part; nitrate of mercury, 1 part; nitric acid (specific gravity, 1.384), 4 parts; water, 120 parts. The article, free from grease, is dipped in the pickle for a second or two.

The following electroplating bath is used: Pure crystallized ferrous sulphate, 40 parts, by weight, and ammonium chloride, 100 parts, by weight, in 1,000 parts, by weight, of water. It is of advantage to add to this 100 parts, by weight, of ammonium citrate, in order to prevent the precipitation of basic iron salts, especially at the anode.

Tin Plating by Electric Bath.—Most solutions give a dead-white film of tin, and this has to be brightened by friction of some sort, either by scratch brushing, burnishing, polishing, or rubbing with whiting. The bright tin plates are made bright by rolling with polished steel rollers. Small articles may be bright-tinned by immersion in melted tin, after their surfaces have been made chemically clean and bright, all of which processes entail much time and labor. Benzoic acid, boric acid, or gelatin may be tried with a well-regulated current and the solution in good working order, but all will depend upon the exact working of the solution, the same conditions being set up as are present in the deposition of other metals. These substances may be separately tried, in the proportion of 1 ounce to each gallon of the tin solution, by boiling the latter and adding either one during the boiling, as they dissolve much easier with the tin salts than in water separately. Tin articles are usually brightened and polished with Vienna lime or whiting, the first being used with linen rags and the latter with chamois leather. Tin baths must be used hot, not below 75° F., with a suitable current according to their composition. Too strong

a current produces a bad color, and the deposit does not adhere well. A current of from 2 to 6 volts will be sufficient. Small tinned articles are brightened by being shaken in a leather bag containing a quantity of bran or by revolving in a barrel with the same substance; but large objects have to be brightened by other means, such as scratch brushing and mopping to give an acceptable finish to the deposited metal.

GILDING AND GOLD PLATING:

Genuine gilding readily takes up mercury, while imitation gilding does not or only very slowly. Any coating of varnish present should, however, be removed before conducting the test. Mercurous nitrate has no action on genuine gold, but on spurious gilding a white spot will form which quickly turns dark. A solution of neutral copper chloride does not act upon genuine gold, but on alloys containing copper a black spot will result. Gold fringe, etc., retains its luster in spirit of wine, if the gilding is genuine; if not, the gilding will burn and oxidize. Imitation gilding might be termed "snuff gilding," as in Germany it consists of dissolved brass, snuff, saltpeter, hydrochloric acid, etc., and is used for tin toys. An expert will immediately see the difference, as genuine gilding has a different, more compact pore formation and a better color. There are also some gold varnishes which are just as good.

The effect of motion while an article is receiving the deposit is most clearly seen during the operation of gilding. If a watch dial, for instance, be placed in the gilding bath and allowed to remain for a few moments undisturbed and the solution of gold has been much worked, it is probable that the dial will acquire a dark fox-red color; but if it be quickly moved about, it instantly changes color and will sometimes even assume a pale straw color. In fact, the color of a deposit may be regulated greatly by motion of the article in the bath—a fact which the operator should study with much attention, when gilding.

The inside of a vessel is gilded by filling the vessel with the gilding solution, suspending a gold anode in the liquid, and passing the current. The lips of cream jugs and the upper parts of vessels of irregular outline are gilded by passing the current from a gold anode through a rag wetted with the gilding solution and laid upon the part.

Sometimes, when gilding the insides of mugs, tankards, etc., which are richly

chased or embossed, it will be found that the hollow parts do not receive the deposit at all, or very partially. When this is the case, the article must be rinsed and well scratch brushed, and a little more cyanide added to the solution. The anode must be slightly kept in motion and the battery power increased until the hollow surfaces are coated. Frequent scratch brushing aids the deposit to a great extent by imparting a slight film of brass to the surface.

In gilding chains, brooches, pins, rings, and other articles which have been repaired, i. e., hard soldered, sometimes, it is found that the gold will not deposit freely upon the soldered parts; when such is the case, a little extra scratch brushing applied to the part will assist the operation greatly and it has sometimes been found that dry scratch brushing for an instant—that is, without the stream of beer usually employed—renders the surface a better and more uniform conductor and consequently it will more readily receive the deposit. In fact, dry scratch brushing is very useful in many cases in which it is desirable to impart an artificial coating of brass upon an article to which silver or gold will not readily adhere. In scratch brushing without the employment of beer or some other liquid, however, great care must be taken not to continue the operation too long, as the minute particles of metal given off by the scratch brush would be likely to prove prejudicial to the health of the operator, were he to inhale them to any great extent.

The following solutions are for gilding without a battery: I.—In 1,000 parts of distilled water dissolve in the following order:

Crystalline sodium pyrophosphate	80 parts
Twelve per cent solution of hydrocyanic acid	8 parts
Crystalline gold chloride	2 parts

Heat to a boiling temperature, and dip the article, previously thoroughly cleaned, therein.

II.—Dissolve in boiling distilled water, 1 part of chloride of gold and 4 parts of cyanide of potassium. Plunge the objects into this solution, while still hot, and leave them therein for several hours, keeping them attached to a copper wire or a very clean strip of zinc. They will become covered with a handsome gold coating.

Aluminum Gilding.—I.—Dissolve 6 parts of gold in aqua regia and dilute the

solution with distilled water; on the other hand, put 30 parts of lime in 150 parts of distilled water; at the end of 2 hours add the gold solution to the lime, shake all and allow to settle for 5 to 6 hours, decant and wash the precipitate, which is lime aurate. Place this aurate of lime in 1,000 parts of distilled water, with 20 parts of hyposulphite of soda; put all on the fire for 8 to 10 minutes, without allowing to boil; remove and filter. The filtered liquor serves for gilding in the cold, by plunging into this bath the aluminum articles previously pickled by passing through caustic potash and nitric acid. This gilding is obtained without the aid of the battery.

II.—The gold bath is prepared with gold dissolved in the usual way, and the addition of salts, as follows: Gold, 20 parts, by weight; sulphate of soda, 20 parts; phosphate of soda, 660 parts; cyanuret of potassium, 40 parts; water, 1,000 parts. The bath ought to be of the temperature of 68° to 77° F.

Amalgam Gold Plating.—Gold amalgam is chiefly used as a plating for silver, copper, or brass. The article to be plated is washed over with diluted nitric acid or potash lye and prepared chalk, to remove any tarnish or rust that might prevent the amalgam from adhering. After having been polished perfectly bright, the amalgam is applied as evenly as possible, usually with a fine scratch brush. It is then set upon a grate over a charcoal fire, or placed into an oven and heated to that degree at which mercury exhales. The gold, when the mercury has evaporated, presents a dull yellow color. Cover it with a coating of pulverized niter and alum in equal parts, mixed to a paste with water, and heat again till it is melted, then plunge into water. Burnish up with a steel or bloodstone burnisher.

Brass Gilding.—On brass, which is an electropositive metal, an electromagnetic metal, such as gold, can be deposited very cheaply from the dilute solutions of its salts. The deposit is naturally very thin, but still quite adhesive. In preparing it, the proportions stated below have to be accurately observed, otherwise no uniform, coherent coating will result, but one that is uneven and spotted.

I.—In 750 parts, by weight, of water dissolve: Phosphate of soda, 5 parts, and caustic potash, 3 parts, and in 250 parts of water, gold chloride, 1 part, and potassium cyanide, 16 parts. Mix both

solutions well and cause the mixture to boil, whereupon the brass articles to be gilded are immersed. The gold in the mixture can be utilized almost entirely. When the solution does not gild well any more a little potassium cyanide is added, and it is used for pre-gilding the articles, which can then be gilded again in a fresh solution. This solution is very weak. A stronger one can be prepared mechanically by dissolving 2 to 3 parts of gold chloride in very little water to which 1 part of saltpeter is added. Into this solution dip linen rags, let them dry in a dark place, and cause them to char into tinder, which is rubbed up in a porcelain dish. Into the powder so made, dip a soft, slightly charred cork, moistened with a little vinegar, or else use only the finger, and rub the gold powder upon the brass articles.

II.—To Give Brass a Golden Color, it is dipped until the desired shade is obtained into a solution of about 175° F., produced as follows: Boil 4 parts of caustic soda, 4 parts of milk sugar, and 100 parts of water for 15 minutes; next add 4 parts of blue vitriol, dissolved in as little water as possible.

Copper and Brass Gilding.—The solutions used to gild copper can be generally used also for brass articles. Copper gilding acquires importance because in order to gild iron, steel, tin, and zinc, they must first be coated with copper, if the boiling method is to be employed. Following is Langbein's bath for copper and brass:

Dissolve 1 part, by weight, of chloride of gold and 16 parts, by weight, of potassium cyanide in 250 parts, by weight, of water; dissolve also and separately, 5 parts, by weight, of sodium phosphate and 3 parts, by weight, of caustic potash in 750 parts, by weight, of cold water. Mix these solutions and bring them to a boil. If the action subsides, add from 3 to 5 parts, by weight, more potassium cyanide. The polished iron and steel objects must first be copper-plated by dipping them into a solution of 5 parts, by weight, of blue vitriol and 2 parts, by weight, of sulphuric acid in 1,000 parts, by weight, of water. They may now be dipped into a hot solution containing 6 parts, by weight, of gold chloride and 22½ parts, by weight, of soda crystals in 75 parts, by weight, of water. This coating of gold may be polished.

Cold Chemical Gilding.—The chemical gilding by the wet process is accomplished by E. E. Stahl with the aid of three baths: A gold bath, a neutralization

bath, and a reduction bath. The gold bath is prepared from pure hydrochloric acid, 200 parts; nitric acid, 100 parts; and pure gold. The gold solution evaporated to crystallization is made to contain 1½ per cent of gold by diluting with water. The neutralization bath consists of soda lye of 6°, of pure sodium hydroxide, and distilled water. The reduction bath contains a mixture of equal parts of 90 per cent alcohol and distilled water, wherein pure hydrogen has been dissolved. The gilding proper is conducted by first entering the article in the gold bath, next briskly moving it about in the neutralization bath, and finally adding the reducing bath with further strong agitation of the liquid. The residues from the gilding are melted with 3 parts each of potash, powdered borax, and potash niter, thus recovering the superfluous gold. The gilding or silvering respectively produces a deposit of gold or silver of very slight thickness and of the luster of polishing gold. Besides the metal solution an "anti-reducer" is needed, consisting of 50 grams of rectified and rosinified turpentine oil and 10 grams of powdered roll sulphur. From this is obtained, by boiling, a syrupy balsam, to which is added, before use, lavender oil, well-ground basic bismuth nitrate, and the solution for gilding or silvering. The last takes place by a hydrochloric solution of aluminum with the above balsam.

Colored Gilding.—A variety of shades of green and red gold can be obtained by the electro-chemical process, which method may be employed for the decoration of various objects of art. In order to produce red gold in the different shades, a plate of pure copper is hung into a rather concentrated gold bath (5 to 6 parts, by weight, per 1,000 parts of liquid), which is connected with the battery in such a manner that gold is deposited on the article immersed in the bath. By the action of the electric current copper is dissolved as well from the copper plate and is separated simultaneously with the gold, so that, after a certain time, a deposit containing a gold copper alloy, conforming in color to the quantities of gold and copper contained in it, is obtained by the electric process. When the desired shade of color of the deposit is reached the copper plate is taken out and replaced by another consisting of the copper gold alloy, likewise produced by electrodeposition, and the articles are now gilt in this liquid. In some large manufactories of gold articles this last coloring is used even for pure

gold articles, to give them a popular color. To produce green gold (alloy of gold and silver), a silver plate is first employed, which is dipped into the gold bath and from which enough silver is dissolved until the separating alloy shows the desired shade. The silver plate is then exchanged for a gold-silver plate of the respective color, and the articles are gilt with green gold.

Gilding German Silver.—In gilding German silver the solution may be worked at a low temperature, the solution being weakened and a small surface of anode exposed. German silver has the power of reducing gold from its solution in cyanide (especially if the solution be strong) without the aid of the battery; therefore, the solution should be weaker, in fact, so weak that the German silver will not deposit the gold *per se*; otherwise the deposit will take place so rapidly that the gold will peel off when being burnished or even scratch brushed.

Gilding of Glass.—I.—In order to produce a good gilding on glass, the gold salt employed must be free from acid. Prepare three solutions, viz.:

a. 20 parts acid-free gold chloride in 150 parts of distilled water.

b. 5 parts dry sodium hydrate in 80 parts of distilled water.

c. $2\frac{1}{2}$ parts of starch sugar in 30 parts distilled water; spirit of wine, 20 parts; and commercial pure 40 per cent aldehyde, 20 parts. These liquids are quickly mixed together in the proportion of 200, 50, and 5 parts, whereupon the mixture is poured on the glass previously cleaned with soda solution, and the gilding will be effected in a short time. The gold coating is said to keep intact for years.

II.—Coat the places to be gilded thinly with a saturated borax solution, lay the gold leaf on this and press down well and uniformly with cotton-wool. Heat the glass over a spirit flame, until the borax melts, and allow to cool off. If the glass is to be decorated with gilt letters or designs, paint the places to be gilded with water-glass solution of 40° Bé.; lay on the gold leaf, and press down uniformly. Then heat the object to 86° F., so that it dries a little, sketch the letters or figures on with a lead pencil, erase the superfluous gold, and allow the articles to dry completely at a higher temperature.

Green Gilding.—This can be obtained conveniently by the galvanic process, by means of anodes of sheet platinum

with the following composition: Water, 10,000 parts, by weight; sodium phosphate, 200 parts; sodium sulphate, 35 parts; potassium carbonate, 10 parts; 1 ducat gold from gold chloride, potassium cyanide (100 per cent), 20 parts. Dissolve the first three salts in 10,000 parts of cold water and add, with stirring, the gold chloride and potassium cyanide. Before the first use boil down the solution thoroughly about one-half, replacing the evaporating water and filter after cooling, in case a sediment should appear. To this gold bath very carefully add some silver bath. The platinum sheets which are to serve as anodes are employed $1\frac{1}{2}$ inches long, $\frac{1}{2}$ inch broad, and $\frac{1}{16}$ of an inch thick. With these anodes the gold tone can be somewhat regulated by hanging more or less deeply into the solution during the gilding. The current should have a tension of 3 to 4 volts. In the case of batteries three Busen elements are connected for current tension. It is difficult to produce old gold on silver, especially if the raised portions are to appear green. It is most advantageous first to lightly copper the silver goods, taking the copper off again on the high places by brushing with pumice stone. After that hang at once in the above gold bath. If the embossed portions should be too mat, brighten slightly by scratching with a very fine brass wire brush. In this manner a handsome brown shade is obtained in the deep places and a green color on the raised portions. This process requires practice. Since this method will produce only a very light gilding, a coating of white varnish will protect the articles from tarnishing.

Incrusting with Gold.—The article is first made perfectly bright, and those places which are to be gilt are covered with a matt consisting of white lead ground with gum water, made into a paste which can be applied like a thick paint by means of a pen or brush. Those places of the metal surface not covered by the paint are coated with asphalt varnish—a solution of asphaltum in benzine to which oil of turpentine is added to render it less volatile. After this is done lay the article in water, so that the white lead paint comes off, and put it into a gilding bath. By the electric current gold is precipitated on the bright parts of the metal. When the layer of gold is thick enough lift the object from the bath, wash, let dry and lay it into a vessel filled with benzol. The asphalt dissolves in the benzol, and the

desired design appears in gold on the bronze or silver ground. This operation may also be performed by coating the whole article with asphalt varnish and executing the design by means of a blunt graver which only takes away the varnish covering without scratching the metal itself. On the parts thus bared gold is deposited by the electric current and the varnish coating is then removed.

Ivory Gilding.—I.—The pattern is painted with a fine camel's-hair pencil, moistened with gold chloride. Hold the ivory over the mouth of a bottle in which hydrogen gas is generated (by the action of dilute sulphuric acid on zinc waste). The hydrogen reduces the auric chloride in the painted places into metallic gold, and the gold film precipitated in this manner will quickly obtain a considerable luster. The gold film is very thin, but durable.

II.—This is especially suitable for monograms. Take gold bronze and place as much as can be taken up with the point of a knife in a color-cup, moistening with a few drops of genuine English gold paint. Coat the raised portions sparingly with gold, using a fine pencil; next, coat the outer and inner borders of the design. When the work is done, and if the staining and gilding have been unsuccessful, which occurs frequently at the outset, lay the work for 5 or 10 minutes in warmed lead water and brush off with pumice stone. By this process very fine shades are often obtained which cannot be produced by mere staining. Since the gold readily wears off on the high places of the work, it is well to lightly coat these portions with a thin shellac solution before gilding. This will cause the gilding to be more permanent.

Mat Gilding.—To obtain a handsome mat gilding the article, after having been neatly polished, is passed through a sand-blast, such as is found in glass-grinding and etching establishments; next, the object is carefully cleansed of fine sand (if possible, by annealing and decocting), whereupon it is gilt and subsequently brushed mat with the brass brush. Where there is no sand-blast, the article is deadened with the steel wire brush, which will produce a satisfactory result, after some practice. After that, treatment is as above. The above-mentioned applies in general only to silver articles. In case of articles of gold, brass, or tombac, it is better to previously silver them strongly, since they are too hard for direct treatment

with the steel wire brush, and a really correct mat cannot be attained. The brushes referred to are, of course, circular brushes for the lathe.

Dead-Gilding of an Alloy of Copper and Zinc.—The parts which are to be deadened must be isolated from those which are to be polished, and also from those which are to be concealed, and which therefore are not to be gilded. For this purpose they are coated with a paste made of Spanish white mixed with water. The articles prepared in this manner are then attached by means of iron wire to an iron rod and suspended in a furnace constructed for this process. The floor of this furnace is covered on four sides with plates of enameled earthenware for receiving the portions spattered about of the salt mixture given off later.

In the middle is an oven constructed like a cooking stove, on which is an iron tripod for carrying the deadening pan; this latter is cemented into a second pan of cast iron, the intervening space being filled up with stove cement. In the middle of the pan is the bottom or sill, provided with a thick cast-iron plate, forming the hearth. On all four sides of the latter are low brick walls, connecting with the floor of the furnace, and the whole is covered with thick sheet metal. On the side of the furnace opposite the side arranged for carrying the pans, is a boiler in which boiling water is kept. On the same side of the furnace, but outside it, is a large oval tub of a capacity of about 700 or 800 quarts, which is kept filled with water. The upper portions of the staves of this tub are covered with linen to absorb all parts that are spattered about.

Powder for Gilding Metals.—I.—In a solution of perchloride of gold soak small pieces of linen which are dried over the solution so that the drops falling therefrom are saved. When the rags are dry burn them, carefully gathering the ashes, which ashes, stirred with a little water, are used for gilding either with pumice stone or with a cork. For the hollows, use a small piece of soft wood, linden, or poplar.

II.—Dissolve the pure gold or the leaf in nitro-muriatic acid and then precipitate it by a piece of copper or by a solution of iron sulphate. The precipitate, if by copper, must be digested with distilled vinegar and then washed by pouring water over it repeatedly and dried. This precipitate will be in the form of very fine powder; it works better and is

more easily burnished than gold leaf round with honey.

Gilding Pastes.—I.—A good gilding paste is prepared as follows: Slowly melt an ounce of pure lard over the fire, add $\frac{1}{2}$ a teaspoonful of juice of squills, and stir up the mixture well, subsequently adding 10 drops of spirit of sal ammoniac. If the mixture is not stiff enough after cooling, the firmness may be enhanced by an admixture of $\frac{1}{4}$ to $\frac{1}{2}$ ounce of pure melted beef-tallow. A larger addition of tallow is necessary if the white of an egg is added. After each addition the mixture should be stirred up well and the white of egg should be added, not to the warm, but almost cold, mixture.

II.—Alum, 3 parts, by weight; salt-peter, 6 parts; sulphate of zinc, 3 parts; common salt, 3 parts. Mix all into a thick paste, dip the articles into it, and heat them, until nearly black, on a piece of sheet iron over a clear coke or charcoal fire; then plunge them into cold water.

Red Gilding.—This is obtained by the use of a mixture of equal parts of verdigris and powdered tartar, with which the article is coated; subsequently burning it off on a moderate coal fire. Cool in water, dip the article in a pickle of tartar, scratch it, and a handsome red shade will be the result, which has not attacked the gilding in any way.

Regilding Mat Articles.—In order to regenerate dead gold trinkets without having to color them again—which is, as a rule, impossible, because the gold is too weak to stand a second coloring—it is advisable to copper these articles over before gilding them. After the copper has deposited all over, the object, well cleaned and scratched, is hung in the gilding. By this manipulation much time and vexation is saved, such as every jeweler will have experienced in gilding mat gold articles. The article also acquires a faultless new appearance. Here are two recipes for the preparation of copper baths:

I.—Distilled boiling water, 2,000 parts, by weight; sodium sulphate, 10 parts; potassium cyanide, 15 parts; cupric acetate, 15 parts; sodium carbonate, 20 parts; ammonia, 12 parts.

II.—Dissolve crystallized verdigris, 20 parts, by weight, and potassium cyanide, 42 parts, in 1,000 parts of boiling water.

Silk Gilding.—This can only be accomplished by the electric process. The

fiber is first rendered conductive by impregnation with silver nitrate solution and reduction of same with grape sugar and diluted alkali, or, best of all, with Raschig's reduction salt. In place of the silver nitrate, a solution of lead acetate or copper acetate may be employed. The silk thus impregnated is treated in the solution of an alkaline sulphide, e. g., sodium sulphide, ammonium sulphide, or else with hydrogen sulphide, thus producing a conductive coating of metallic sulphide. Upon this gold can be precipitated by electrodeposition in the usual way.

Spot Gilding.—Gilding in spots, producing a very fine appearance, is done by putting a thin coat of oil on those parts of the metal where the gilding is not to appear; the gold will then be deposited in those spots only where there is no oil, and the oil is easily removed when the work is finished.

Gilding Steel.—Pure gold is dissolved in aqua regia; the solution is allowed to evaporate until the acid in excess has gone. The precipitate is placed in clean water, 3 times the quantity of sulphuric acid is added and the whole left to stand for 24 hours in a well-closed flask, until the ethereal gold solution floats on top. By moistening polished steel with the solution a very handsome gilding is obtained. By the application of designs with any desired varnish the appearance of a mixture of gold and steel may be imparted to the article.

Wood Gilding.—I.—The moldings, ledges, etc., to be gilded are painted with a strong solution of joiners' glue, which is left to harden well, whereupon 8 to 10 coatings of glue mixed with whitening are given. Each coat must, of course, be thoroughly dry, before commencing the next. After this has been done, paint with a strong mixture of glue and minium, and while this is still wet, put on the gold leaflets and press them down with cotton. To impart the fine gloss, polish with a burnishing agate after the superfluous gold has been removed.

II.—Proceed as above, but take silver leaf instead of gold leaf, and after all is thoroughly dry and the superfluous silver has been removed, apply a coating of good gold lacquer. The effect will be equally satisfactory.

Zinc Gilding.—I.—Gilding by means of zinc contact may be accomplished with the following formula: Two parts, by weight, of gold chloride; 5 parts, by weight, of potassium cyanide; 10 parts,